Burst Pulse Analysis

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The Problem: SIGMET's "pb" utility in dspx will not lock on properly to the burst pulse. The pb window shows a jittery pulse of indeterminate level. The utility itself calculates a level of approximately –4.6dBm

The Analysis:

In Table 1, the path for the burst pulse is shown with the nominal losses and gains. The Burst Mixer loss is shown in bold because the value of –20 shows we are into compression on the mixer (normally there is approximately a 9dB loss).

Table 1, Calculated Burst Power

Adaptation	Descriptive Name	value	Peak (dBm)	Average (dBm)
	XMIT POWER	88.45	88.45	
	DUTY CYCLE (at 1013.5hz)	-28.14		
TR17	Arc Detector	-0.05	88.40	60.26
TR18	Harmonic Filter	-0.16	88.24	60.10
TR19	Circulator	-0.16	88.08	59.94
TR21	Waveguide Klystron Switch	-0.14	87.94	59.80
TR23	1DC Coupler	-34.91	53.03	24.89
TR32	High Power Transmitter Coupler Pad	-3.02	50.01	21.87
R48	RF Sample to A33 Pad	-0.67	49.35	21.21
R49	A33 Pad	-5.85	43.50	15.36
	Transmitter Power Splitter J1 to J5	-6.33	37.17	9.03
	Burst Attenuator	-20.00	17.17	-10.97
	Burst Mixer	**-20.00**	-2.83	-30.97
	Anti-Alias Filter	-2.00	-4.83	-32.97

Table 2 shows readings taken with a power meter and a spectrum analyzer. The readings from the Spectrum Analyzer were not what we expected, they do not appear to show actual peak power, but do give us an idea of power differences. The power meter measurement is not valid on the mixer output since it's a broadband device and would give us power from RF as well as the desired IF.

Table 2, Power Readings

Source	RF into Mixer	Mixer Output	Anti-Alias Output
Spectrum	-13.25	-16.17	-18.17
Power Meter	-11.91		-33

Table 3 shows the affects of attenuating the burst pulse into the mixer. What it shows is that with 20dB attenuation, we are well into compression of the mixer. It takes approximately 36dB attenuation to get to the linear range of the mixer. Table 4 shows the characteristics of the mixer. This mixer was chosen based on our LO Power, and it matches well. The RF input maximum power given is for average power, so we are not near the limit for power. Our large duty cycle is causing compression. As can be seen from Table 1 and adjusting for different burst attenuation, it takes approximately 36dB attenuation to get to +1dBm peak, where we measure a linear response. It actually takes a couple dB less since the cable has some attenuation not accounted for here. This compression does not affect the quality of the burst, either on the spectrum analyzer or with an oscilloscope. It just makes the output power non-linear with regard to the input power.

Table 3, Burst Pulse Power

Attenuation	7dBm LO mixer & 6dB LO coupler	Miteq mixer & LO splitter	7dBm LO mixer & LO splitter
20	-3	-5.2	
30	-4.60	-5.5	-6.5
33		-6.6	
36	-7.44	-8.3	-9.2
40	-11.18		
43	-14.11		

Table 4, Mini-Circuits ZEM-4300 Mixer

Specification	Units	Value
LO/RF Frequency Range	Mhz	300-4300
IF Frequency Range	Mhz	DC-1000
Conversion Loss	dB	-9.5 max
1dBm Compression	dBm	+1
LO Power	dBm	+7

We used an oscilloscope to view the actual burst pulse after the mixer, and then after the anti-alias filter (see Figures 1 and 2 and note the difference in vertical scale between them). The rise times for these pulses are ~120nsec and ~150nsec, respectively, exactly what we would expect through a bandpass filter. The pulse was extremely stable, and no phase or amplitude jitter could be seen. Since the signals were terminated into 50Ω, we are able to calculate the peak power of each pulse, converting the peak voltage to RMS, then using $E = V^2/R$, and converting to dBm. We got –3.15Dbm and –4.61dBm, respectively, showing good agreement with Table 1 and the results of SIGMET's pb utility for the latter reading (the reading out of the Anti-Alias Filter). This also agrees well with the value in Table 2 when corrected for duty cycle (short pulse, PRF of 1013, giving a duty cycle of –28dB).

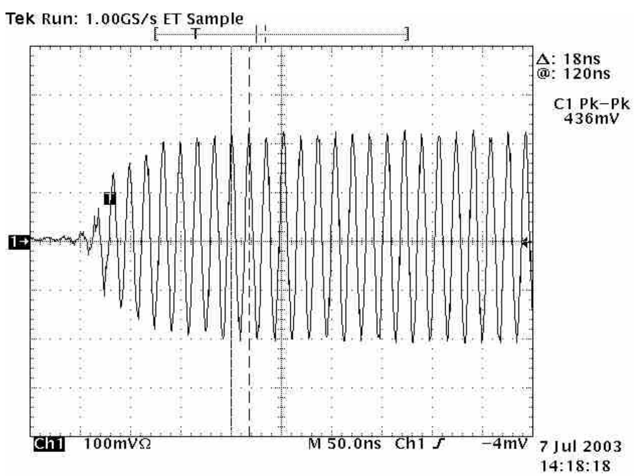

Figure 1, Burst Pulse after Burst Mixer

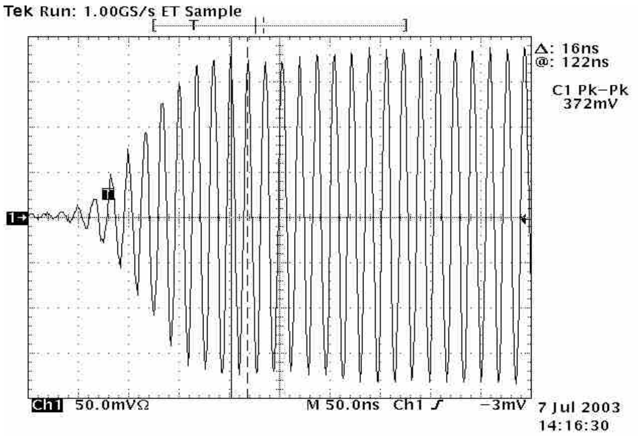

Figure 2, Burst Pulse after Anti-Alias Filter

When viewing the entire burst pulse (Figure 3) with the digital oscilloscope (a Tektronix 420A), we see instability and amplitude jitter, apparently due to insufficient capture speed. However, when we viewed the same signal with an analog oscilloscope (a Tektronics 2445A), the entire burst was stable, and the envelope had no jitter. It showed the same amplitude as the digital oscilloscope with a 120nsec rise time and a 1.64μsec 3dB envelope. This instability is similar to the instability seen with the pb utility.

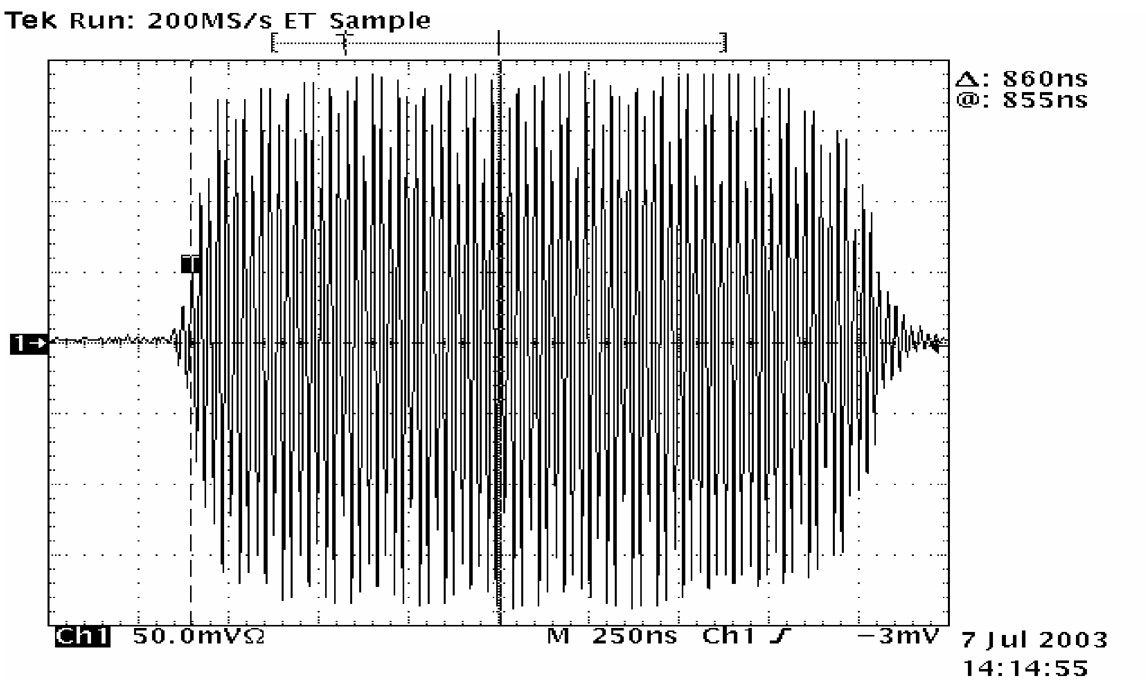

Figure 3, Entire Burst Pulse

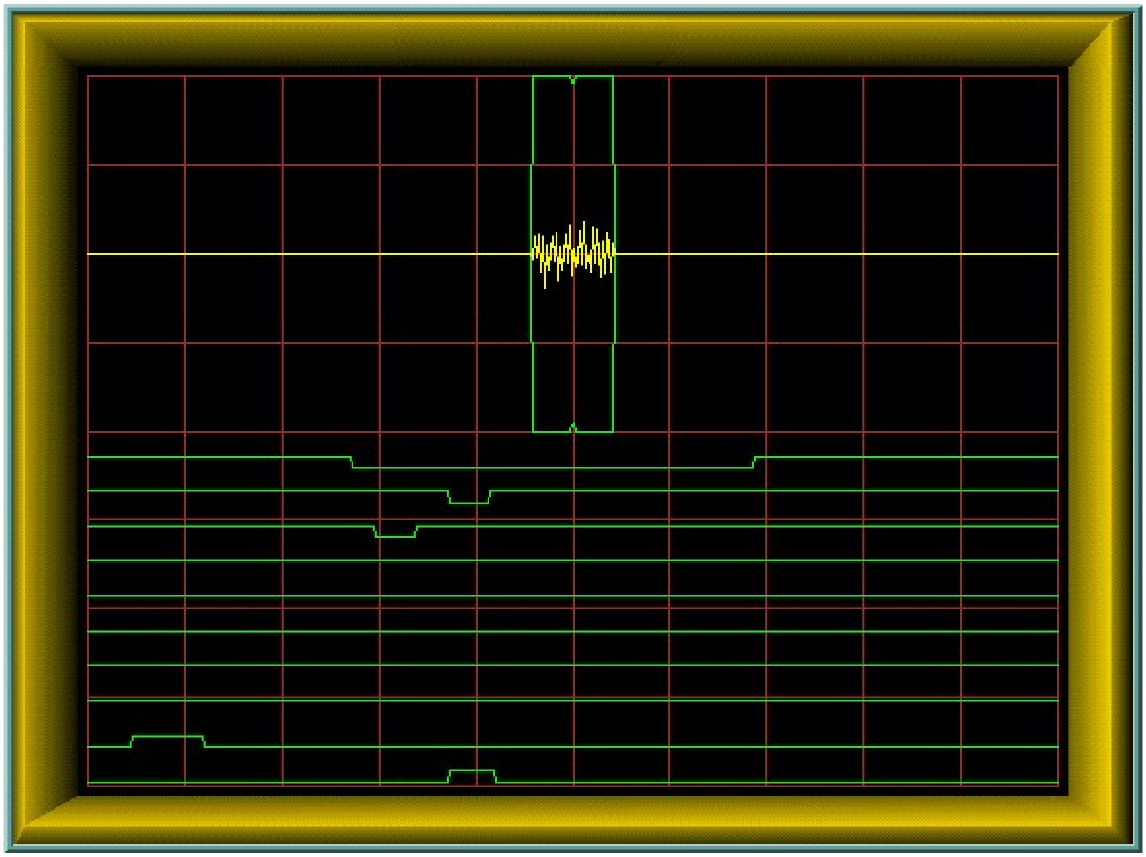

Figure 4, SIGMET pb utility

Figure 4Shows the burst pulse as captured by the IFD. It appears ragged and fluctuates. We used a Signal Generator and input directly into the burst pulse jack on the IFD. At 57.5491Mhz, the utility locks on to the proper frequency and shows the proper power, but the window shows the same instability from 0dBm to –15dBm. At 60Mhz, the window appears much more stable and full. We experimented with other frequencies (it was interesting to see 36Mhz, the capture frequency) also, and always got an accurate power reading, even when aliasing kept us from accurate frequency measurements.

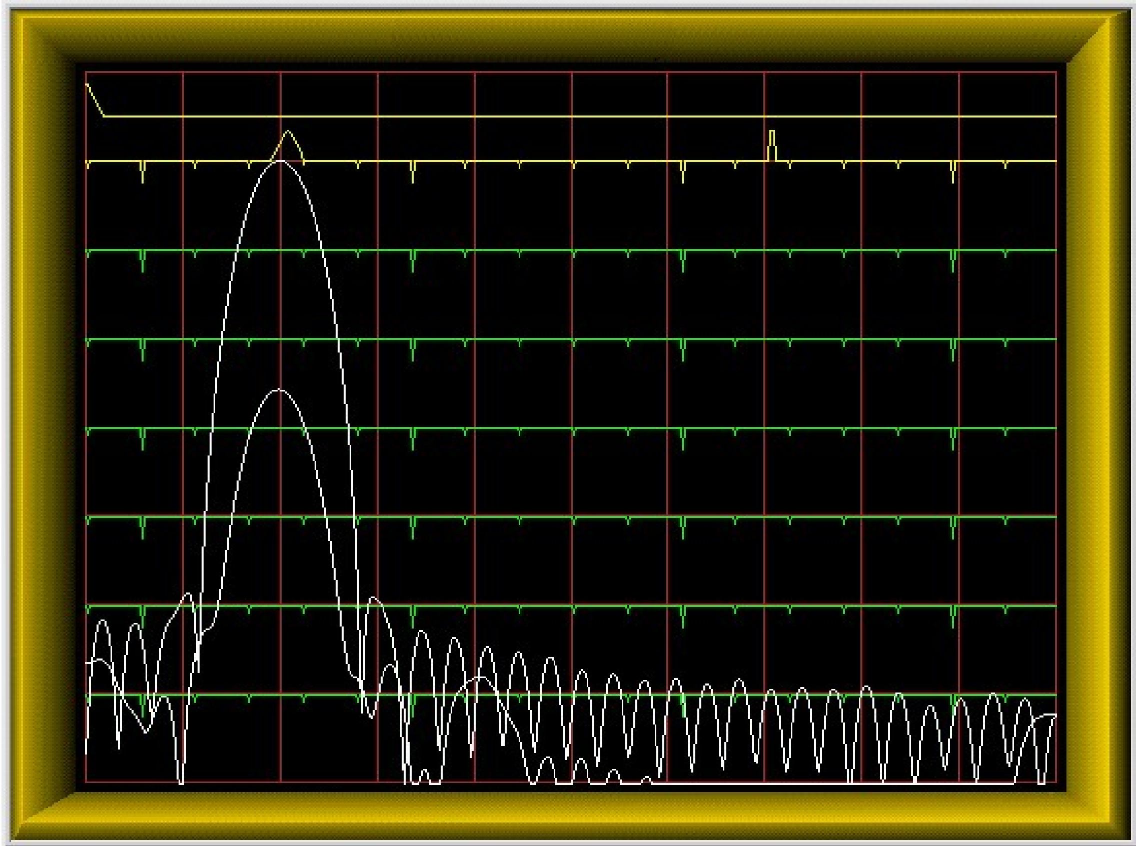

Figure 5, SIGMET ps utility

Figure 5shows the spectral analysis of the filter and the burst pulse. The pulse is quite stable, but the apparent level is well below what we expect. However, the power level shown in text is –4.6dBm, well within specified capture design. Using the Signal Generator, this signal locked on quickly, and displayed higher powers. However, 0dBm did not go all the way to the top of the window.

Conclusion: Our best current guess as to the instability in the pb window is the ratio of our IF to the IFD capture frequency. We see the same apparent instability when viewing the entire burst pulse on a digital oscilloscope. Our analysis shows the pulse to be at a good level for capture with no apparent anomalies, even though we are well into compression on the mixer. We continue to investigate.